

WIRELESS NETWORK SITE SURVEY TOOL

Related Application

[01] This application is related to and claims the benefit of the filing date of U.S. Provisional Application No. 60/274,324 for: Wireless Network Site Survey Tool.

Technical Field

[02] The present invention relates generally to the field of computer networks. More specifically, the present invention relates to wireless local area networks.

Background

[03] Local area networks (LANs) allow a plurality of computers to communicate with each other. A wireless LAN is one type of LAN. A wireless LAN allows computers to communicate with each other without wires. An advantage of a wireless LAN is that it allows computers to be moved within a physical area ("service area") without regard to physical connections. Common wireless transmission mediums used in wireless LAN networks include infrared light and radio wave propagation. One type of wireless LAN system uses an IEEE 802.11 technology standard protocol to communicate within the network. Other common protocols used on wireless LAN systems include BLUE TOOTH, HOME RF WIDEBAND, IEEE 802.11b and IEEE 802.11a.

[04] Conventional wireless LAN systems typically use "access points." An access point is a device that acts as a transmitter and a receiver. Each access point is coupled to interface with an "infrastructure" network such as an Ethernet network. In a wireless LAN, computers or stations communicate with the access point via the wireless transmission medium. That is, messages generated by the computers are sent to an associated access point and messages received by the computers are transmitted through an associated access point. For the system to work properly, computers must be placed within a certain distance from its associated access point to allow for transmission and reception of signals. Therefore, proper placement of the access points

is paramount. According to current practice, access points are placed using a signal strength meter. This often results in the use of more access points than is necessary.

[05] For the reasons stated above, and for other reasons stated below which will become apparent to those skilled in the art upon reading and understanding the present specification, there is a need in the art for improvements in placing access points in a wireless LAN.

Summary

[06] The above-mentioned problems and other problems are addressed by the present invention and will be understood by reading and studying the following specification. In one embodiment, a tool for providing a site survey of a wireless network is disclosed. The tool comprises a network server, a plurality of access points and a portable computer. The network server has a server application module to create and distribute data packets. The plurality of access points are coupled to send and receive data packets from the server. The portable computer is in wireless communication with the plurality of access points and has a two-dimensional surface area map on a data grid. The portable computer receives the data packets sent by the network server. Moreover, the portable computer includes instructions that are adapted to compute at least one of throughput and packet error rate at selected locations within a network coverage area and display the at least one of throughput and packet error rate on the two-dimensional surface area map to provide a site survey of the wireless network coverage.

[07] In another embodiment, a tool for providing a site survey of a wireless network includes a network server, a plurality of access points and a mobile client. The network server is used to create and distribute data packets. The plurality of access points are coupled to send and receive data packets from the server. The mobile client is in wireless communication with the plurality of access points. The client has a two-dimensional surface area map on a data grid. The client includes instruction that are

adapted to compute at least one of throughput and packet error rate at selected locations within a network coverage area when the client receives data packets sent by the network server. The client displays the at least one of throughput and packet error rate on the two-dimensional surface area map to provide a site survey of the wireless network coverage.

[08] A method of providing a site survey of a wireless network comprising, sending data packets through the wireless network, collecting data on the data packet transmission, calculating throughput and error rate and implementing the throughput and error rate into a two-dimensional vector surface area map to convey a graphical representation of the wireless network coverage.

[09] Another method of providing a site survey of a wireless network comprising, importing a floor plan image of a building to be surveyed into a portable computer wirelessly coupled to a network server via access points, marking the location of the access points on the imported floor plan image, positioning the portable computer at selected locations within the building, marking the locations of the portable computer on the imported floor plan image, sending a request signal from the portable computer to the network server via the access point requesting a signal containing packets be created by the network server and sent back to the portable computer while the portable computer is at the then current location marked on the imported floor plan image, receiving the request signal at the network server via the access points, generating the packet requests, sending the packet requests multicast to the portable computer, computing the packet error rate and throughput and displaying the quality of signal strength based on the packet rate and throughput on a two-dimensional vector map imposed over the imported floor plan image.

[10] A method of providing a site survey comprising, importing a floor plan image of an area to be surveyed into a client that is wirelessly coupled to a server via access points, marking the location of the access points on the floor image map, positioning the client at various locations within the area to be surveyed, marking the

various locations of the client on the floor plan image, receiving packet signals with the client from the server at each of the various locations, calculating at least one of throughput and packet error rate for each of the various locations and displaying the quality of the signal based on the at least one of throughput and packet error rate on a two-dimensional vector map imposed over the floor plan image.

[11] A computer-readable medium including instructions for implementing a method comprising, importing a floor plan image of an area to be surveyed into a client that is wirelessly coupled to a server via access points, marking the location of the access points on the floor image map, positioning the client at various locations within the area to be surveyed, marking the various locations of the client on the floor plan image, receiving packet signals with the client from the server at each of the various locations, calculating at least one of throughput and packet error rate for each of the various locations and displaying the quality of the signal based on the at least one of throughput and packet error rate on a two-dimensional vector map imposed over the floor plan image.

[12] Another computer-readable medium including instructions for implementing a method comprising, receiving a command to generate a test signal of data packets with a network server, generating a test signal in response to the command, wherein the test signal contains a desired amount of packets, further wherein each packet has a defined number of bits, sending the requested data packets in the test signal at predefined time intervals to a client.

Brief Description of the Drawings

[13] Figure 1 is a block diagram of a wireless network system of the prior art

[14] Figure 2 is a block diagram of software modules according to one embodiment of the present invention.

[15] Figure 3 is a flow chart illustrating the operation of one embodiment of the present invention.

[16] Figure 4 is a screen shot of a graphic user interface (GUI) showing a representative floor plan according to one embodiment of the present invention.

[17] Figure 5 is a screen shot of a GUI showing a tool bar of one embodiment of the present invention.

[18] Figure 6 is a screen shot of a GUI showing a representative floor plan having an access point dropped therein according to one embodiment of the present invention.

[19] Figure 7 is a screen shot of a GUI showing portion of a representative floor plan having a data point dropped therein according to one embodiment of the present invention.

[20] Figure 8 is a screen shot of a GUI showing a representative floor plan incorporating a site survey according to one embodiment of the present invention.

Detailed Description

[21] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific preferred embodiments in which the inventions may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that logical, mechanical and electrical changes may be made without departing from the spirit and scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the claims and equivalents thereof.

[22] Embodiments of the present invention provide a tool for conducting a site survey of network coverage to guide the user in the placement of access points. The results of the survey are displayed in a two-dimensional (2D) vector surface area map using a parametric graph. Data is collected through a user datagram protocol (UDP)/Internet protocol (IP) socket based management protocol. This protocol collects

empirical data on throughput and packet error rate. Moreover, embodiments of the present invention transmit data from all access points coupled to a wired network at the same time, advantageously exposing the tool to potential co-channel interference.

[23] The management protocol has two parts, a client application and a server application. The client application tells the server, through the management protocol, how many packets to transmit, packet size, and destination IP address. This can be set to unicast or multicast depending on what type of data the client would like transmitted. The client gathers this data through the management protocol and formats it according to the throughput quality parametric scale the user has set. This data may then be displayed in a two-dimensional vector graphics manner, using a three color parametric graph to discriminate quality.

[24] The wireless network site survey tool according to one embodiment of the present invention provides a hardware independent tool (for both client and access point) that works on IEEE 802.11 equipment (e.g., Intersil PRISM, CISCO Aironet, DLINK Wireless, Linksys 802.11). Moreover, embodiments of the present invention may also integrate with a program like Vision2000 to provide ease of constructing building layout. Further, embodiments of the present invention measure and display the co-channel and adjacent channel interferers (adjacent access points on the same and different channels) to provide cell and multi cell results. Two-dimensional arrays for access point placement in multi-level structures may also be provided. Additionally, Layer 4 management protocol (riding on transport control protocol (TCP)/IP and UDP/IP) may be included for ease of configuration, use and data collection.

[25] A wireless LAN network that implements the IEEE 802.11 technology standard of the prior art is shown in Figure 1. As shown, a distribution system 106 is coupled to a plurality of access points 104. In one embodiment, the distribution system is an Ethernet network. A plurality of stations (STA) 102 each communicate with an associated access point 104 for transferring data. Typically, each STA 102 communicates with its associated access point by radio wave propagation. Although,

the present invention has been described as using the IEEE 802.11 standard protocol and IEEE 802.11 technology, it will be understood in the art that any packet based wireless networking protocol and equipment could be used and that the present invention is not limited to systems using the IEEE 802.11 standard protocol and equipment.

[26] Referring to Figure 2, a block diagram illustrating one embodiment of the present invention is shown. As shown, the distribution system 106 is coupled to a server 108. The server 108 provides a packet based signal to the distribution system 106. The distribution system 106 is coupled to the APs 104. In addition, a mobile client or station (client/STA) 110 is wirelessly coupled to the distribution system 106 to send and receive signals throughout the area being surveyed. In one embodiment, the client/STA 110 is a portable computer. Moreover, as shown in Figure 2, in one embodiment, the wireless signals sent to the client/STA 110 are multicast, through each AP 104 to expose co-channel interference.

[27] Figure 3 is an illustration of software modules 200 for a site survey tool according to an embodiment of the present invention. The first module is a data collection module 202. The data collection module 202 is used to collect data between the client 102 and its associated access point 104. The data collection module 202 is hardware independent and collects throughput in Mbps from the server 106. In addition the data collection module 202, collects the packet error rate (PER) from the server 106. The data collection is event driven and typically should take less than 2 seconds to collect. The data collection module 202 implements user data protocol (UDP) (broadcast or unicast). For example, the data collected could have a throughput of 2.23 Mbps, a PER of 12% and the packets received could be 998.

[28] The next module is the data conditioning module 204. The data conditioning module 204 is used to place relative data points on a data grid, to interpolate and extrapolate data, and to set parametric limits on the data. The data conditioning module 204 interpolates data between known data points up to one grid

and extrapolates data to up to one grid. The data conditioning module 204 positions relative data points to the nearest grid intersection. The data conditioning module 204 also applies a parametric qualification to the data using a user defined minimum and maximum.

[29] A surface area mapping module 206 takes data from the data conditioning module and maps it to a 2D surface area map on the data grid. This surface area map module 206 further calculates, using the data parametric used for data conditioning, the positioning of lines of different colors on the surface area map to reflect the throughput by regions of the surface area map. The number of lines per grid and the number of grids are user definable with a user interface (UI).

[30] A registry module 208 is used to save to and read from a windows registry. More specifically, the registry module 208 is used to store all changeable and management variables (VARS) to the windows registry. In one embodiment, the register module 208 takes all of the user options and server VARS and stores them in a registry key that uses identifiable names. An example of an identifiable name is PSS\parameters\server_IP=132.158.87.99. The registry is updated upon an APPLY/OK or exit command. Moreover, when the application is started the registry is read and the global and public application variables are populated with the stored settings.

[31] A graphical interface module 210 is used to communicate with and link the aforementioned modules 202, 204, 206 and 208. The graphical interface module 210 is also responsible for open, save, new and print calls. In one embodiment, the graphical interface module 210 includes iconic markers used for the data points. These data points can be clicked from a tool bar and dropped on the surface area map thereby leaving an iconic marker representing the relative location. An access point locator is also selected from a tool bar and dropped on the surface area map by clicking the icon then clicking the surface area map. A data point can also be collected at the access point location using the same method.

[32] After the data point of an access point is dropped on the surface area map or floor plan, the data collection module 202 is called to collect the data. The data is then conditioned by the data conditioning module 204 and sent to the surface area mapping module 206. The data is then displayed on a graphical user interface (GUI). The GUI has an import feature for a floor plan image in .bmp, .gif, .jpg and .tif files. This image will allow relative data points to be collected.

[33] In one embodiment, the GUI has a save feature that saves all of the data, the relative locations, the access point locations and other user defined settings to a file named .psp (main file with data points and relative locations), a file named .psa (character delimited access points file), and a file named .psf (copy of the original floor plan graphics file). In another embodiment, these files are loaded from a load feature restoring the application state to the previous state.

[34] The GUI remembers the last floor plan loaded and the last project and provides them in a drop down list. The parametric maximum and minimum for the throughput can be changed with a key that is hidden and displayed from a drop down list. An advanced screen is used for other GUI parameters such as grid size, grid increment, grid line size, surface area line size, etc. The GUI has a tool bar that contains an open icon, a save icon, a print icon, a data icon, an AP icon, an advanced configuration icon and a help icon. In one embodiment the tool bar is located proximate the top of the GUI. The GUI also has a status bar that indicates the then current status of the test. The status bar also has a clock. In one embodiment, the status bar is located at the bottom of the GUI. The GUI further has standard drop down menus for all the program features. Moreover, there should be an advanced networking form displaying the current test in real time and allowing the user to set the number of packets sent, the packet size, the server IP address, the destination IP address as well as an Apply/OK/Hide control.

[35] Lastly, a server application 212 is responsible for handling requests from clients and sending data packets of the requested sized and number. The server

application 212 is also responsible for putting packet sequence numbers into a body of a frame for sniffing and debug reasons. The server application 212 runs and is installed separately from a client module. The server application module 212 launches as a tool tray icon with no GUI. In one embodiment, the GUI can be displayed by double clicking on the tool tray icon or right clicking and selecting maximize. The GUI should display the number of packets sent, the client IP address, packets retransmitted and a Hide/Exit control. In one embodiment, a drop down menu is used to provide these options. The server application module 212 will service any client request regardless of IP as long as the request is formatted appropriately. For example, the server application module may monitor PORT 10262 for incoming requests formatted as:

UDP:Number-Of-Packets_To_Send@Packet_Size&Destination_IP

- a. Protocol, i.e. UDP or TCP separator [:].
- b. Number_of_Packets, i.e. 100 separator [@].
- c. Packet size, i.e. 1472 separator [&].
- d. Destination IP address, i.e. 255.255.255.255 OR Your_IP-Address.

[36] In addition the mechanics of the client application protocol are the inverse of the server application. Thus, for example, the client application may transmit on PORT 10263 when the user initiates a data collection event. The data transmit request in this example could be formatted as:

UPD:Number_Of_Packets_To_Send@Packet_size&Destination_

- a. Protocol, i.e. UDP or TCP separator [:].
- b. Number_Of_Packets, i.e. 100 separator [@].
- c. Packet size, i.e. 1472 separator [&].
- d. Destination IP address, i.e. 255.255.255.255 OR Your_IP_Address.

[37] Referring to Figure 4 an illustration how the present invention is implemented is shown. The client imports a floor plan image 310 of a building (400).

An example of an imported floor plan image 310 is shown in Figure 5. The client then marks where the access points (AP) are located by clicking on the AP icon 420 on the tool bar 311 and then clicking the floor plan image 310 where the AP is physically located (402). The AP icon 420 is illustrated in tool bar 311 of Figure 4. Another example of a tool bar 311 is illustrated in Figure 6. Moreover, an example of a floor plan image 312 having an AP 424 inserted is shown in Figure 7. Referring back to Figure 4, the client sets a data point by physically placing the client/STA (portable computer) at a desired location within the building to be surveyed and clicking the "man" icon 422 on the tool bar 311 and then clicking where they are physically located in the floor plan image 310 (404). The "man" icon 422 is illustrated in the tool bar 311 of Figure 4. An illustration of the data point 426 inserted in a floor plan image 313 is shown in Figure 8.

[38] Referring back to Figure 4, the client also sets the parameters of the packets it wants sent to it from a server 316 (405). This information is sent to the server 316 each time a data point is set. For example, as shown, the parameters could be: 1. packets requested: 1000, 2. packet size: 1500, 3. packet destination: multicast and 4. IP port: XXXX. The data is then transferred to an associated access point via the IEEE 802.11 wireless standard (408). The request is then received from the client at the server 316 (410). The server 316 is coupled to the access point 408 using the IEEE 802.3 standard or other wired packet base network standard. The server then creates the requested packets using the parameters sent by the client. The server then sends the requested packets to the access point and back to the client via the 802.11 wireless standard protocol (408).

[39] The client receives packet (414). At (414) the packet number received is counted, each packet size is determined and the time it takes to send the packets is tracked. A timer function is then implemented (416). The packets are traveling at a relatively fast speed, typically in the order of every millisecond. Therefore, all packets should be sent within one second. In one embodiment, the timer function monitors when the packets are received to determine when 2 seconds have past since the last

packet (LP) has been received. If time $LP > 2$ the test is complete. If time- $LP < 2$ the timer function keeps waiting.

[40] The PER and throughput are then calculated (418). The throughput equals the number of packets received (PC) times the bit size (PS) of the packets divided the time it took to send the data (fast-packet – first packet). Therefore, throughput = $PC * PS / (\text{Last-packet} - \text{First-Packet})$. $PER = PC / \text{Packets Requested}$. A 2D Vector display of data is then displayed over the floor plan image 314.

An example of the floor plan image having the 2D Vector data is illustrated in Figure 9. As shown, a parametric graph illustrates how the wireless network throughput is quantified on the floor image. By implementing a parametric graph using three different colors only an upper limit and a lower limit are defined. A first color, is used for anything above the upper limit. As second color is used for anything below the lower limit and a third color is used for anything in between the upper and lower limit. As marked in Figure 8, in one embodiment, a red color is used for anything above the upper limit, a green color for anything below a lower limit and a yellow for anything in between the upper and lower limit. The upper and lower limits for throughput are shown at control 320. As shown, in this illustration, 1.0 Mbps is set as the lower limit. Any value under 1.0 Mbps indicates areas where the throughput is unacceptable. The upper limit is set at 3.1 Mbps. Any value over 3.1 Mbps indicates areas where the access points don't need to be so close together. Values that fall within the upper and lower limits indicate area were you do not need to add or take away access points. The values of the upper and lower limits can be changed to accommodate specific system requirements.

[41] Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement, which is calculated to achieve the same purpose, may be substituted for the specific embodiment shown. This application is intended to cover any adaptations or variations of the

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
1990	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100